Cylinder Boring / Honing Finishes

When an engine is rebuilt, the cylinders usually need attention. Wear tends to create taper in the upper part of the cylinder that can reduce ring sealing and increase blow by and oil consumption if not removed. The cylinder may also be out of round, scored or have other damage that requires correcting before a new set of rings will seal properly.

Boring out cylinders to accept oversized pistons or sleeves has long been a common practice in the engine rebuilding business. Boring allows worn blocks to be salvaged, and stock cylinder bores to be enlarged for more displacement. More recently, boring is also being used to install special cylinder liners with hard surface treatments in high performance racing engines. The hard liners (Nikasil) almost eliminate ring and bore wear so the engine can run race after race with no increase in bore clearances blow by.

The main objective when refinishing the cylinders is to make the walls as straight as possible (no taper), the bores as round as possible (minimal distortion, which is especially important with low tension rings), to have the right amount of crosshatch for good oil retention and ring support, and to produce a surface finish that meets the requirements of the rings. This is done by boring and/or honing the cylinders in one or several steps with various types of abrasives.

CYLINDER BORE DISTORTION. As important as surface finish is for proper ring seating and lubrication, bore geometry is probably even more important on today's engines. Bore distortion is common in the upper cylinder area because of the forces created by the head bolts when they are tightened down. Changes in coolant temperature and circulation within the block can also cause bore distortion as can normal and abnormal combustion pressures. To get as round a hole as possible, many engines with thin wall castings should be honed/bored with a torque plates and head gasket bolted to the block. The torque plate simulates the loads placed on the block when the head is installed, allowing the bore to be honed to truer dimensions.

Bore distortion can be described by levels of "order." A first order bore is one that is perfectly round with no distortion in any direction. A second order bore is one with an oval distortion, typically caused by machining errors or heat transfer. Rings can usually tolerate some second order distortion by conforming to the bore. But the lower the ring tension, the less able the rings are to conform to bore distortion. A third order distortion results in a triangular shaped hole, and is usually caused by a combination of second and fourth order distortions. A fourth order distortion is a bore with a cloverleaf or squared shape. This type of distortion is caused by the location of the head bolts. The amount of distortion can vary from almost nothing up to a couple thousandths of an inch! With today's tight piston-to-wall clearances, even .0005" of bore distortion may be too much on some applications, so the rounder the bore the better.

After honing, the cylinders need to be cleaned remove residual abrasive and metallic debris that is left in the bores. Washing and scrubbing with warm soapy water will remove most of the unwanted material. But washing alone does not loosen or remove surface items such as torn or folded metal that can wear rings

and delay ring seating. The only way to get rid of this material and smooth the bores is to "polish" the bores after honing with some type of flexible abrasive brush.

CYLINDER CROSSHATCH. Most OEMs and ring manufacturers say the angle of the scratches in the crosshatch pattern should be about 45 degrees to each other, or about 22 to 32 degrees to the horizontal deck surface. The crosshatch angle should be the same throughout the length of the cylinder and not flatten out at either end.

If the crosshatch angle is too steep, the rings can pump oil or experience excessive rotation which will accelerate wear in the rings and piston lands. If the crosshatch angle is too shallow, it can have a ratcheting effect as the rings pass over the valleys, preventing the rings from receiving proper lubrication. A proper crosshatch will also have enough valleys to retain oil, but not too much oil. The secret here is getting the right amount of retained oil volume (Vo). If the crosshatch scratches are too deep or there are too many valleys (not enough peaks and bearing area), the engine will use excessive oil. The greater the retained oil volume, the higher the oil consumption. This can be caused by finish honing with stones that are too coarse (#150 or less). On the other hand, if the crosshatch scratches are too shallow or there is too much plateau on the bore surface, the volume of retained oil may not be enough to keep the rings lubricated. This will cause accelerated ring and cylinder wear. This can be caused by finish honing with stones that are too fine (#400 or greater).

Honing hard engine bock and cylinder liner materials in recent years, Nikasil coatings have provided a challenge for engine builders. Nikasil is a hard coating of nickel and silicon carbide about .0025˝ to .003˝ thick that is applied to cylinder bores to improve wear resistance. Invented by the German firm Mahle, Nikasil was originally developed for the Mercedes Wankel rotary engine. It has been used by BMW and Porsche in some of their engines, and is also used in many motorcycle and marine engines, and even many NASCAR engines. Smaller shops that have only portable honing equipment, you can't exert enough pressure with diamond to hone Nikasil. The best advice here is to use #220 silicone carbine and just do a couple of strokes to deglaze the cylinder. If a cylinder has to be bored to oversize, cut it out with a boring bar and then hone in the usual manner to achieve the desired dimensions and finish.

Remember To Clean The Bores. To wrap up our article on bore finish, we need to say a few words about cleanliness. All your efforts to produce an ideal bore finish, crosshatch and near perfect geometry can be undone if the cylinders are not thoroughly cleaned after they have been honed. Scrubbing with hot, soapy water is still one of the best ways to remove honing debris that can cause ring problems if it remains in the cylinders. Some rebuilders tell us they even do a second cleaning step that involves wiping out each cylinder with ATF or WD-40 oil to remove anything that might have been missed by the soapy water.

Thank you for looking,

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